



Reactor Simulator Testing Overview

***Presented by
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Background



Nuclear Systems Team

- focuses on technology development for a variety of space nuclear systems
 - state-of-the-art capability in non-nuclear testing (electric heaters to closely mimic the static and dynamic thermal performance of nuclear fuels)
 - fission reactor and radioisotope systems.
 - applications of surface and spacecraft power & nuclear propulsion(thermal, electric, advanced concepts like fusion, plasma, etc.)

Program/Project Support

- primary Program/Project support
 - Fission Surface Power efforts supported by ETDD through the Nuclear Systems Office. The MSFC program lead is Mike Houts/VP33. Technology Demonstration Unit (TDU)
 - TDU is an end-to-end system test of a reactor simulator (RxSim), Power conversion Unit, and Heat Rejection System in a thermal vacuum.
 - TDU is intended to demonstrate the major element of a notional FSPS.
 - RxSim perform integrated testing of the TDU components



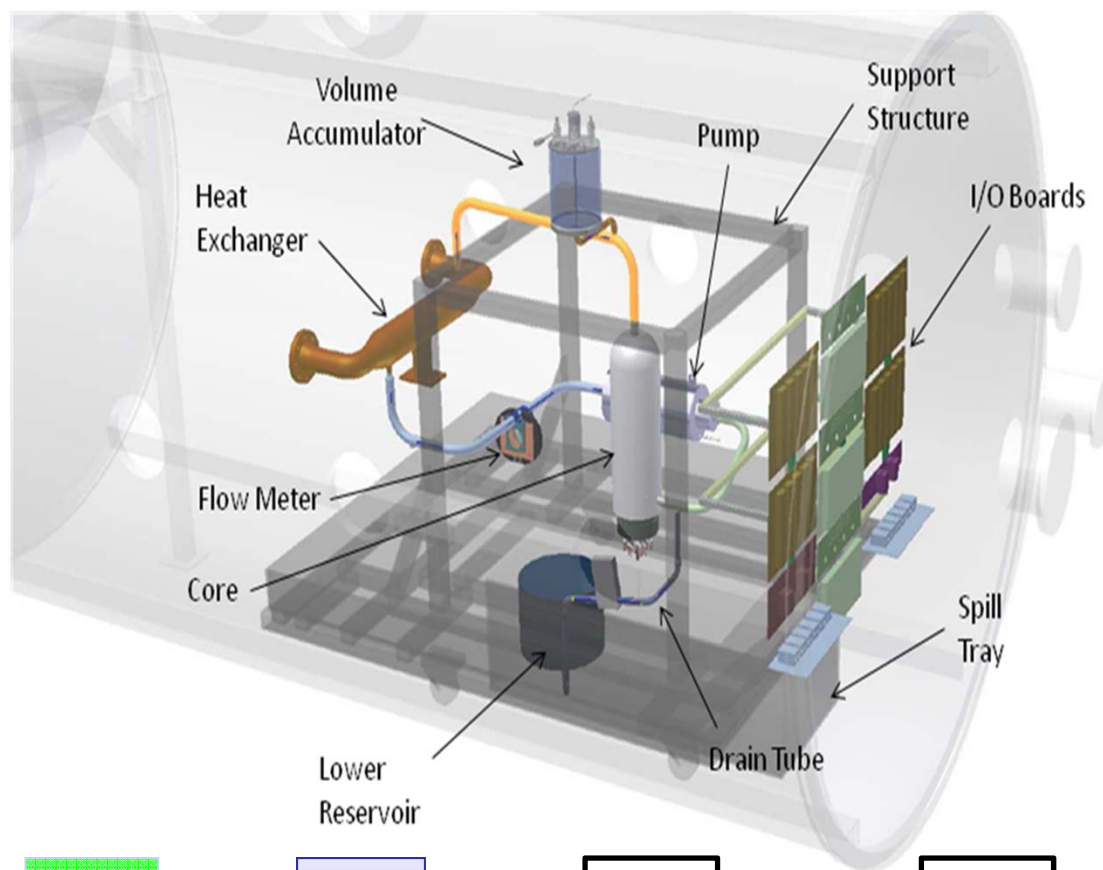
Scope Reactor Simulator



Technology Demonstration Unit



Reactor Simulator



Gas
and
Vacuum
Racks

Facility
Gas,
Vacuum,
& Power
Panels

Power
Rack

Data
and
Control
Rack



Reactor Simulator Testing Overview



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OBJECTIVE

- integrated testing of the TDU components

TESTING SUMMARY

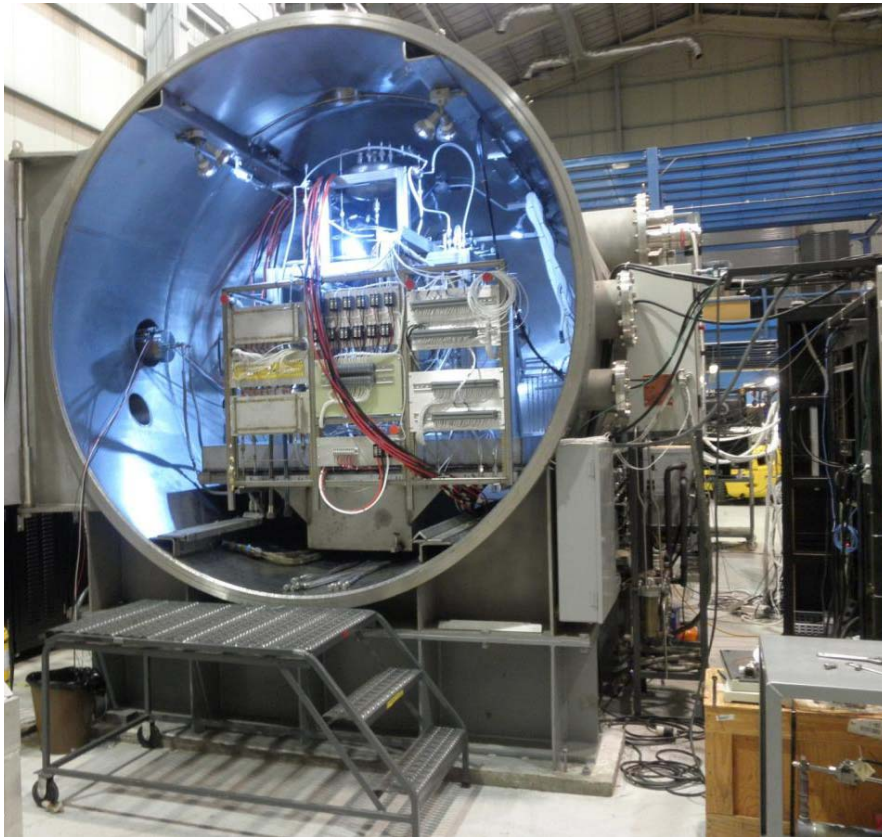
- verify the operation of the core simulator, the instrumentation and control system, and the ground support gas and vacuum test equipment.
- thermal test heat regeneration design aspect of a cold trap purification filter
- pump performance test at pump voltages up to 150 V (targeted mass flow rate of 1.75 kg/s was not obtained in the RxSim at the originally constrained voltage of 120 V)

TESTING HIGHLIGHTS

- gas and vacuum ground support test equipment performed effectively for NaK fill, loop pressurization, and NaK drain operations.
- instrumentation and control system effectively controlled loop temperature and flow rates or pump voltage to targeted settings.
- cold trap design was able to obtain the targeted cold temperature of 480 K. An outlet temperature of 636 K was obtained which was lower than the predicted 750 K but 156 K higher than the cold temperature indicating the design provided some heat regeneration.
- ALIP produce a maximum flow rate of 1.53 kg/s at 800 K when operated at 150 V and 53 Hz.



Reactor Simulator Integrated Setup



Reactor Simulator in Chamber



User Interface Controls & Gas & Vacuum Panels



Core & Pump Power Panels



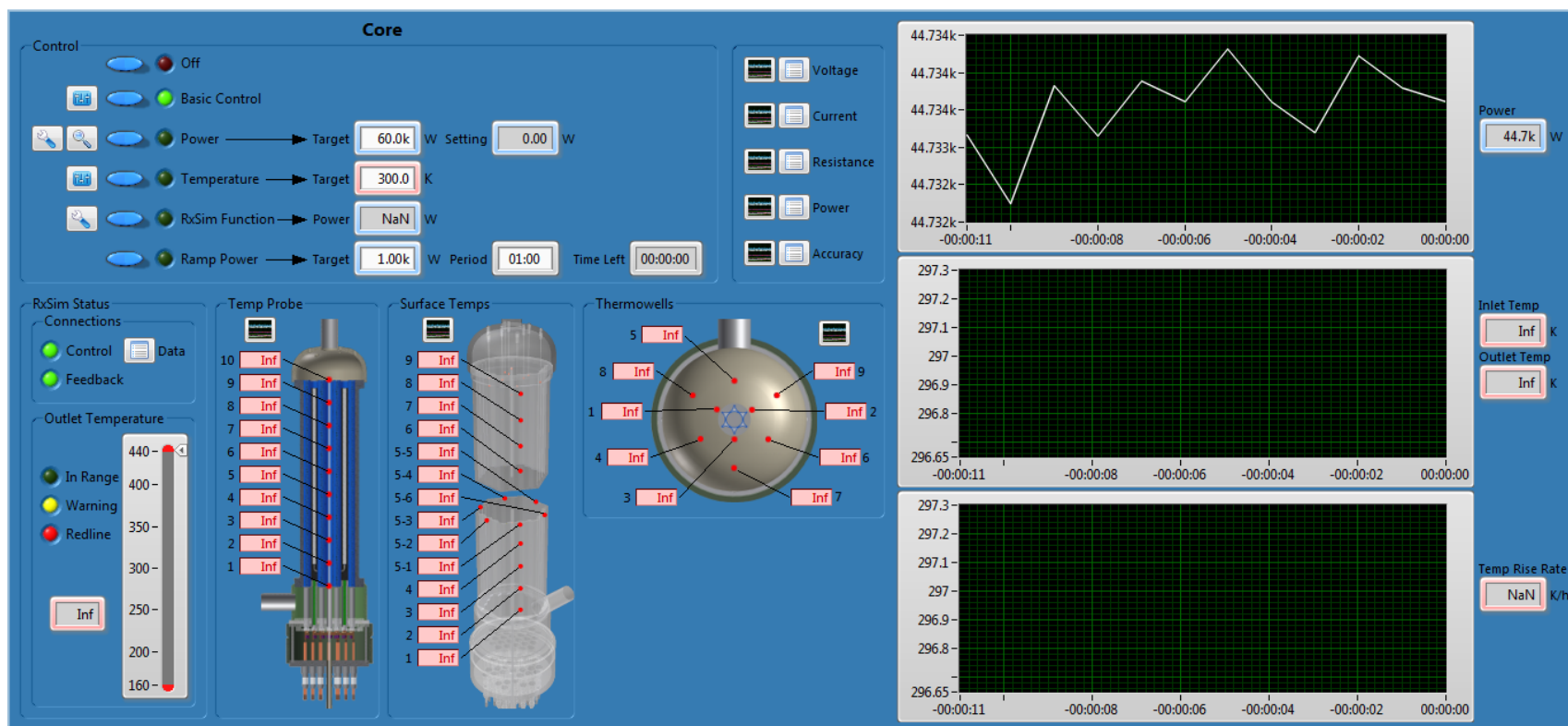
Core Simulator Control System Modes



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1. **Basic:** Control current (I) and voltage (V) settings of each heater zone in the core simulator
2. **Power:** Control total power setting for the core simulator
3. **Power Ramp:** Control total power from starting point to new set point over period of time.
4. **Temperature:** Control the NaK outlet temperature of the core simulator.
5. **Reactor Simulator Function:** Remotely control core power by an external Labview real time controller that runs a Simulink model simulating the feedback response of a nuclear reactor.





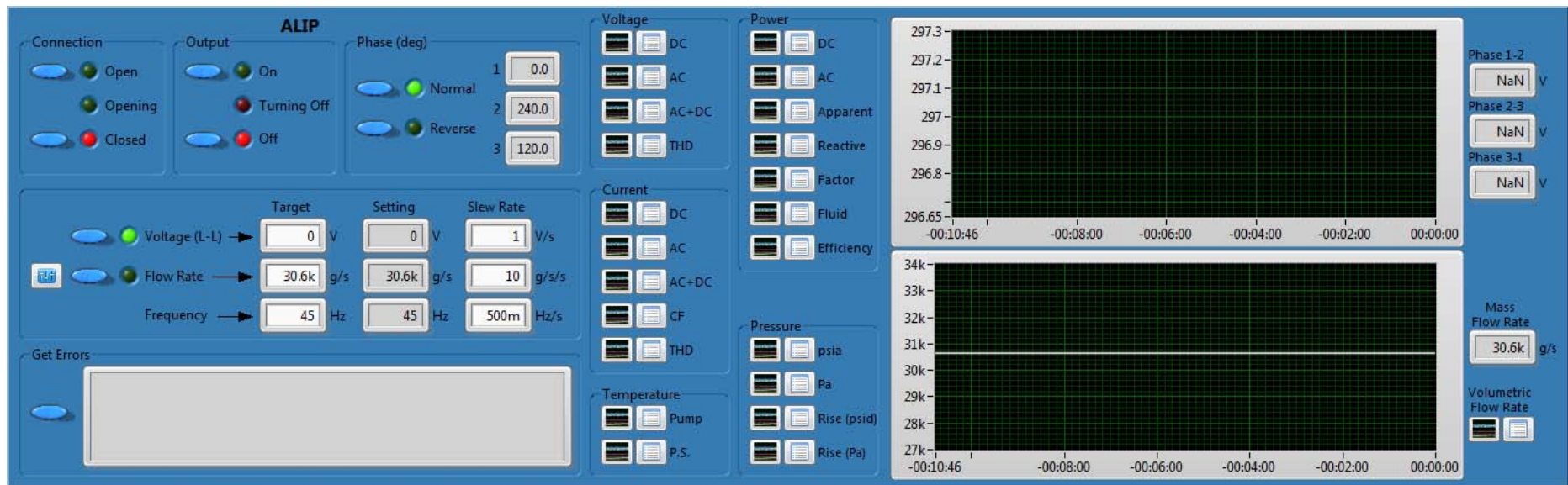
ALIP Control System Modes



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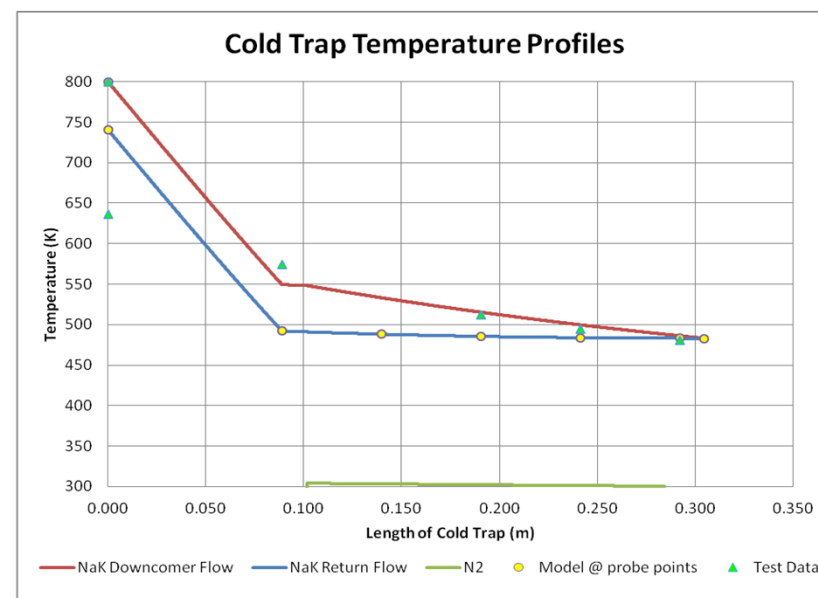
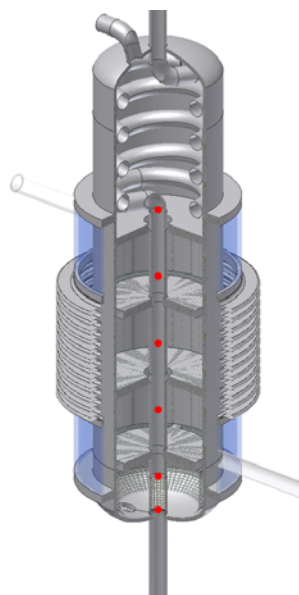
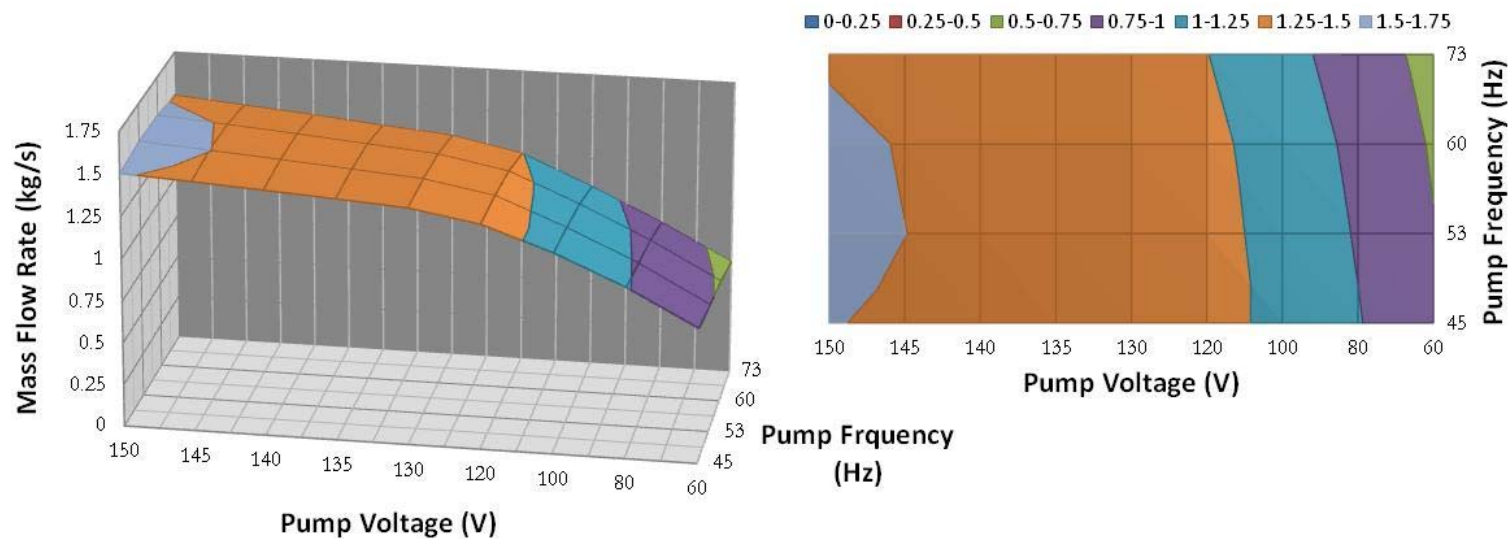
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1. **Voltage:** control the line-line voltage setting of the ALIP power supply
2. **Flow Rate:** control the NaK mass flow rate





Testing Highlights





Outcomes



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Questions?

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